Semi-annually Report for January - June, 1997
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NAS5-31716

Abstract

The algorithm-development activities at USF during the first half of 1997 have concentrated on data collection and theoretical modeling. Three posters and one talk were given at the 4th International Conference, Remote Sensing for Marine and Coastal Environments in Orlando, during March 17 to 19 , 1997. Five talks were given at ASLO 97 in Santa Fe, New Mexico during February 10 –14, 1997. An algorithm-comparison workshop was held in Santa Barbara, CA in January, and preliminary results look excellent. Papers were submitted to the SeaWiFS project, and Applied Optics for publishing.

Tasks Accomplished:

1. Five cruises and one calibration experiment were completed.

a. Florida Bay and Florida Strait cruise

1) January 18 to January 23, 1997

2) NOAA and LANDSAT funded boat time

3) Transects from the Florida Bay to the Florida Strait

4) For Case II algorithm development with bottom visible.

b. OCTS sea truth cruise at MOBY

1) February 21 to March 2

2) NASA-funded ship time by Dennis Clark

3) Near Hawaii in the North Pacific Ocean

4) Remote sensing reflectance technique comparison.

c. Florida Bay and Florida Strait cruise

1) March 3 to March 10, 1997

2) NOAA funded ship time

3) Transects from Florida Bay to Florida Strait

4) For Case II algorithm development with bottom visible.

d. White Sands Instrument Calibration with U. of Arizona

1) March 22 to March 26, 1997

2) NASA-funded trip

3) Mount Lemmon

4) Clean-air, low-humidity intercalibration of solar transmissometers
And irradiance meters.

e. South China Sea Cruise

1) April 15 to May 2nd

2) Taiwan NSF-funded ship time

3) Transects from Kuroshio onto the continental shelf and into
coastal plumes from Chinese rivers.

4) Test and modify Case II chl a algorithm for CDOM-rich waters.

f. Florida Bay and Florida Strait cruise

1) June 28 to July 2, 1997

2) ONR and NASA funded boat time

3) Transects from the Florida Bay to the Florida Strait

4) For Case II algorithm development with bottom visible, grass bed

mapping and LANDSAT, OCTS vicarious calibration.

2. A talk, ‘Experimental Determination of Spectral Absorption by Iron-Bearing Aerosols: Applications to Remote Sensing Imagery’, was given by C. Cattrall et al. at Orlando.
Three posters were also presented ‘Skylight Correction of Video Images: An Airship Shadow Approach’ by M.L. Carder et al.; ‘Remote Sensing Reflectance Algorithms Developed to Correct Underwater Coral Imagery for the Effects of Optical Depth and Turbidity’, by P.D. Pratt et al.; and ‘Bottom Depth and Type for Shallow Waters: Hyperspectral Observations from a Blimp’ by Z. Lee et al.

In a study of a blimp transect over Tampa Bay (Florida), hyperspectral upwelling radiance over the sand and seagrass bottoms was measured. These measurements were converted to hyperspectral remote-sensing reflectances values. Using a shallow-water remote-sensing-reflectance model, in-water optical properties, bottom depths and bottom albedos were derived analytically and simultaneously by an optimization procedure. In the process, curvatures of sand and seagrass albedos were used. Also used was a model of the absorption spectrum of phytoplankton pigments. The derived bottom depths were compared with bathymetry charts and found to agree well. This study suggests that a low-flying blimp is a useful platform for the study and mapping of coastal water environments and for validation of satellite classification of imagery. The optical model as well as the data-reduction procedure used are practical for the retrieval of shallow water optical properties from low-flying aircraft.

3. Five talks were given at ASLO: ‘In Situ Optical Data Collected Aboard Unmanned Underwater Vehicles in Coastal Water’ by D.K. Costello et al.; “A predictive simulation of

spectral ocean color in the Sargasso Sea" by W.P. Bissett, et al.; "A dual-path, long-path absorption spectrometer for obtaining absorption coefficients of dissolved organic matter(DOM)" by Peacock et al.; "AUV Data: Interpretation in terms of aircraft and satellite imagery" by Renadette, et al.; and 'Absorption coefficients and path elongation factor: influence on remote sensing of shallow-water bathymetry' by Lee, Z. P et al.

In passive remote sensing of shallow-water bathymetry, usually "effective" attenuation coefficients for a water body are used. In this study, the attenuation coefficient of a water body is explicitly expressed as the product of the absorption coefficient and an optical path-elongation factor. In the retrieval of bottom depth, it is found that one major source of error comes from the "pure" water absorption coefficients used in the process. For a series of remote-sensing measurements made near Key West (Florida), results using the pure water absorption cruises of Smith and Baker, of Pope, and a mixture of Pope and Tam and Patel curves were compared. These show that the absorption curve of Smith and Baker leads to shallower bathymetric estimates than were measured. Also in this study, a spectral path elongation factor was considered, with an averaged spectral path elongation factor derived for use in future bathymetric studies.

4. Ken Carder and Steve Hawes attended the SeaWiFS Bio-Optical Algorithm Mini-Workshop.

The SeaWiFS Bio-Optical Algorithm Mini-Workshop group was developed out of informal meetings conducted during the Halifax Ocean Optics XIII conference (October 21-25, 1996). The SeaBAM workshop was held at UCSB during January 22-24, 1997.

SeaBAM Participants:

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* Gerald Moore +44 1752 633432
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PURPOSE:

* Finalize the operational SeaWiFS chlorophyll-a and CZCS-pigment algorithms.

* SeaWiFS Bio-optical Algorithm Performance Goal: Establish algorithms meeting SeaWiFS accuracy goals (35% accuracy over range of 0.05-50 mg/m3; SeaWiFS TM Vol.1).

APPROACH:

* Settle on definition of "CZCS pigments" (present definition = [chl a +pheo]).

* Establish a clear definition of accuracy & identify the appropriate statistical parameter(s) for quantification of accuracy (see message archive for more details).

* Establish criteria for final selection of "best" algorithm for both pigment parameters.

* Establish algorithms to be compared and identify probable reasons for differences.

Candidate algorithms were separated into two groups: semi-analytical and empirical. Our work focuses on semi-analytical algorithms, of which there were two candidates at the workshop.

The workshop participants constructed a single validation data set that all algorithm developers can use to test their algorithms. Previously, individual groups used their own individual data sets for validation and/or development.

They decided on which statistical parameters are to be used to evaluate algorithm performance. It was decided that log-transformed variables (i.e., water-leaving radiance values and chlorophyll concentration) are to be used and that reduced-major axis (RMA) regression be used. RMA regression was chosen because it is well-suited for data that has equal error or noise on both axes. Other statistics to be used to evaluate the candidate algorithms are RMS error and bias error.

They are planning to turn the results of this exercise into a SeaWiFS Technical Memorandum (blue book). Chapters will discuss an overview of meeting objectives, ground rules & procedures and a summary of the results; algorithm evaluation criteria; reports on individual data sets by PI; and reports on individual algorithm performance by PI.

The main benefit of this workshop lay in the fact that we could all work at the computers together on everyone's data. Previous workshops merely brought everyone together to present results. The computer facilities provided by the Santa Barbara group (at ICESS) and the small working groups involved allowed a great deal of interaction and progress as a community toward deciding on a final algorithm.

After the SeaBAM workshop, there have been numerous follow-ups requiring attention. Using the new data set, we have re-evaluated our algorithm, we have brought more bio-optical data from the equatorial Pacific into the arena, we have developed methods to evaluate the data sets to screen inconsistencies, and have modified our default chlorophyll algorithm.

We have developed a method of sorting ocean color data based on the amount of phytoplankton pigment packaging. Pigment packaging affects the amount of light absorption per unit of chlorophyll within the phytoplankton cells. This method utilizes the measured water-leaving reflectances themselves, so it is applicable to satellite data. Certain parameters within our algorithm are assigned different values based on the amount of pigment packaging determined for a location and season. A set of average, or "global" parameters are used as a first estimate. When the method for sorting pigment packaging becomes more mature, algorithm parameters can be adjusted on a regional, or on a pixel-scale basis.

The results of our post-workshop analyses and a description of the bio-optical data that we contributed to the global data set are described in a manuscript that we submitted to the SeaWiFS Project. This manuscript is to be included as a chapter in a NASA Technical Memorandum.

5. A paper titled ‘Satellite-Sensor Calibration, Verification Using The Cloud-Shadow Method’, by P. Reinersman et al. is submitted to Applied Optics for publishing.

An atmospheric-correction method which uses cloud-shaded pixels together with pixels in a neighboring region of similar optical properties is described for use with high-resolution(e.g. 30m pixels) satellite or aircraft data. This cloud-shadow method uses the difference between the total radiance values observed at the sensor for these two regions, thus removing the nearly identical atmospheric radiance contributions to the two signals(e.g. path radiance and Fresnel-reflected skylight). What remains is largely due to solar photons backscattered from beneath the sea to dominate the residual signal. Normalization by the direct solar irradiance reaching the sea surface and correction for some second-order effects provides the remote-sensing reflectance to

the ocean at the location of the neighbor region, providing a known “ground target” reflectance spectrum for use in testing the calibration of the sensor.

A similar approach may be useful for land targets if horizontal homogeneity of scene reflectance exists about the shadow. Monte Carlo calculations have been used to correct for adjacency effects and to estimate the differences in the sky light reaching the shadowed and neighbor pixels.

Anticipated Activities:

1. The relationships between temperature anomalies and nutrients in regard to the packaging effect will be explored in order to reduce uncertainty in the chlorophyll algorithm using Bering Sea data and upwelling data from the Arabian Sea , Monterey Bay, Southern California Bight, and the East China Sea.

2. Research expeditions to be completed :

   a. SeaWiFS cal/val cruise to the Gulf of Mexico in September 1997.

Publications:

1. Hou, W., K. L. Carder, D. K. Costello, 1996 “Scattering Phase Function of Very Large Particles in the Ocean,” SPIE Proceedings Vol. 2963, pp.579-584.
2. Bissett, W.P., J.S. Patch, K.L. Carder, and Z.P. Lee, 1996 “Pigment Packaging and Chlorophyll a-Specific Absorption in High-Light Oceanic Waters,” SPIE Proceedings Vol. 2963, pp. 358-374.
3. Lee, Z. P., K.L. Carder, R.G. Steward, T.G. Peacock, C.O. Davis, and J.L. Mueller, 1996

"Remote-Sensing Reflectance and Inherent Optical Properties of Oceanic Waters Derived From Above-Water Measurements," SPIE Proceedings Vol. 2963, pp. 160-166.

4. Pratt, P., K.L. Carder, D.K. Costello, 1996 " Algorithms for Path Radiance and Attenuation to Provide Color-Corrections for Underwater Imagery, Characterize Optical Properties and Determine Bottom Albedo" SPIE Proceedings Vol. 2963, pp. 753-759.
5. Reinersman, P., K. Carder, F. Chen, 1997 "Satellite-Sensor Calibration, Verification Using The Cloud-Shadow Method" submitted to Applied Optics for publishing.
6. Carder, K.L., S. Hawes, and Z. Lee, 1997 "Tests of a Semi-analytical Case I and Gelbstoff Case II SeaWiFS Algorithm with a Global Data Set" submitted to SeaWiFS Project for publishing.